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Effect of Storage Media on Fracture Resistance of Reattached Tooth Fragments

Dr. Suman Poonia[*1], Dr. Akanksha Katewa[2], Dr. Pawan Soni[3], Dr. Monika kumari Khairwa[4], Dr. Mahendra Buri[5], Dr. vishvas kularia[6]

[*1]MDS, Senior lecturer, Department of Conservative Dentistry and Endodontics, RAJASTHAN DENTAL COLLEGE AND HOSPITAL Jaipur.

[2]MDS Senior lecturer, Department Periodontology and Oral Implantology , Rajasthan Dental college and Hospital.jaipur.

[3]Senior lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental college,Jaipur.

[4]Senior lecturer, Department of orthodontics and Dento facial orthopaedics, Rajasthan Dental college and Hospital, Jaipur.

[5]Senior lecturer, Department of orthodontics and Dento facial orthopaedics, NIMS Dental college and Hospital, Jaipur.

[6]Private practitioner, BDS, Apex dental clinic, sadul colony ,Bikaner, Rajasthan.

***Corresponding author**

Dr. Suman Poonia

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ABSTRACT

Background: The present study was planned to compare the fracture resistance of fractured incisor tooth fragments stored in four storage media namely, dry air, milk, normal saline or egg white which were eventually reattached using nanohybrid flowable composite.

Material and methods: Forty- eight freshly extracted maxillary incisor were divided in to four groups.Teeth were then sectioned and fragments were stored in dry air (Group A),milk (Group B),Normal saline (Group C), and Egg white (Group D).The fragments were reattached using Nanohybrid flowable composite and tested on the Universal testing machine.Stastical analysis was performed using one way analysis of variance and post hoc Tukey's test.

Results: Post hoc Tukey's test was performed for group wise comparison that showed no statistically significant difference in fracture resistance values between Group A and Group D ($p=0.61$, $p> 0.005$); Group B and Group D ($p=0.25$, $p> 0.005$); Group C and Group A ($p=0.66$, $p>0.005$); Group D and Group A ($p=0.61$, $p> 0.005$). ANOVA indicated no significant difference between Group A, Group B, Group C, Group D.

Conclusion: This study shows that the use of storage media for the hydration of the fractured tooth fragment does affect its fracture resistance. Within the limitations of this study, it is concluded that Normal saline offers highest fracture resistance for 2 h. followed by Milk, with least being in Egg white.

Keywords: *Fracture, Storage media, Tooth fragments*

1. INTRODUCTION

Traumatic tooth fractures are the common reason for seeking dental care. Most dental injuries occur between 2 and 3 years and between 8 and 12 years of age; they are more common in boys than in girls because of their active involvement in extracurricular activities.[1] The most frequent cause of trauma are falls; bicycle, motorcycle, and car accidents; sports activities; collision with other people and objects; and domestic violence fights and physical assault.[2] Prevalence of trauma to maxillary incisors accounts for about 37%; this is because of their anterior positioning and protrusion caused by the eruptive pattern.

Coronal fracture is the frequent type of dental trauma in the permanent dentition. Eighty percent of traumatized incisors have fracture line proceeding in an oblique direction from labial to lingual aspect.[3] Dental fractures are classified by the World Health Organization as uncomplicated (cracks and/or enamel and dentin fractures) or complicated (with pulp exposure and/or periodontal involvement). Fortunately, uncomplicated fractures are more frequent and require less complex treatment.[4] Avulsion, or exarticulation, is a complete displacement of a tooth from its alveolar socket as a result of trauma. Traumatic tooth avulsion constitutes 0.5%- 16% of all traumatic injuries of permanent anterior teeth.[5].

The concept of reattachment began in 1964 by Chosack and Eidelman. Reattachment of fragment can provide good and long-lasting aesthetics because the gross anatomic form, color and surface texture of the tooth are maintained. It is more conservative and is a reasonably simple procedure. It restores tooth function and elicits an immediate positive emotional and social response from the child.[6] The reattached fragments are prone to re-fracture if another traumatic episode occurs or under non-physiological use of the restored teeth. Therefore, most concerns have been directed towards the fracture strength of reattached teeth.

The reattachment procedure usually involves storage and preparation of the fragment prior to its reattachment, and these procedures are important determinants of the overall clinical outcome. The results of several studies have shown that fragment discoloration is due to dehydration of dentin in the fragment and decreased bond strength between the tooth remnant and fragment.[7]

The objective of this study is to evaluate the effect of storage media on fracture resistance of reattached tooth fragments.

2. MATERIAL AND METHODS

Forty- eight freshly extracted human maxillary incisor teeth extracted due to therapeutic reason with intact crown structures were collected. Teeth with defects such as fractures, decalcification, or caries were discarded. Forty- eight freshly extracted human maxillary incisor teeth with intact crown structures were stored in distilled water until the time they were intentionally fractured. Cleaning and removal of tissue remnants on the root surfaces were carried out using curettes and ultrasonic tips.

(1) **Intentional fracture of extracted sound teeth**: The cervico-incisal distance was measured for each of the tooth on the labial surface. One-third of this distance was then calculated and marked on the labial surface from the incisal edge. The tooth was cut on the marked line perpendicular to its long axis with a low-speed diamond disk. (fig.1)

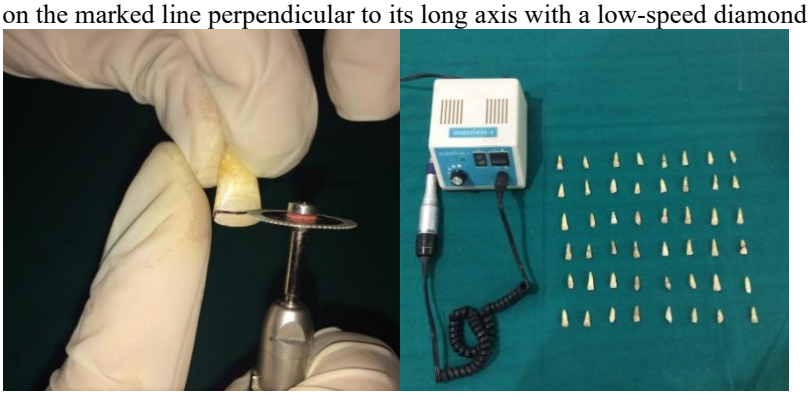


fig .1 Intentional fracture of teeth

(2)**Storage of the fractured fragments in appropriate storage media for 2 h**: Immediately after fracturing, the fragments were stored in separate marked containers with appropriate storage media (dry, milk, normal saline, and egg white) for 2 h and the remaining tooth structure was stored in artificial saliva until reattachment.(fig. 2,3)

Group	Environment	Length of time (hours)
A	Dry	2
B	Milk	2
C	Saline	2
D	Egg White	2

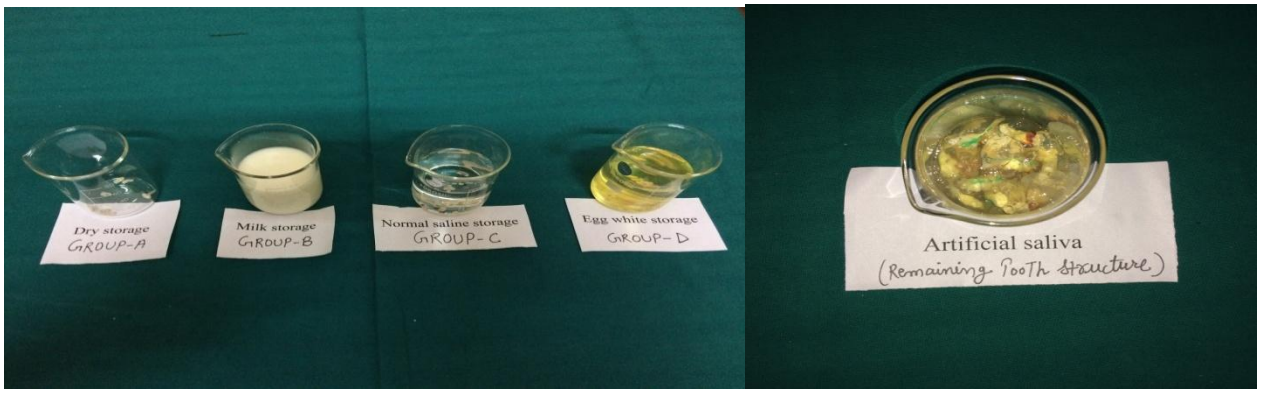


fig. (2,3)fractured fragments in appropriate storage media .Remaining tooth structure in Artificial saliva

(3)**Reattachment of fractured teeth using flowable composite resin**: The fragments and the remaining tooth structure were rinsed in distilled water. Fragments were reattached after 2 hr by means of simple reattachment technique. About 37% phosphoric acid was applied to the fragment and the tooth for 15 s, rinsed for 10 s followed by air drying for 5s. Bonding agent (Prime and Bond NT, Dentsply, India) was applied in two consecutive coats and surfaces were dried for 5 s using an air syringe to allow solvent evaporation. The bonding agent was then light cured for 20 s in the fractured fragment and 20 s in the tooth remnant. Nanohybrid flowable composite (fusion flow ®, India) was applied on the surface of the fragment and tooth remnant. The fragment was then positioned back to the tooth remnant by means of a sticky wax (to carry the fractured fragment).

(4)**Incubation of prepared samples at 37°C in artificial saliva**: After reattachment, all the samples were kept in artificial saliva and incubated at 37°C for 48-72 h. Each sample was then embedded in a self-cure acrylic resin block such that only the coronal portion of the tooth was exposed.

(5)**Fracturing the samples using Universal Testing Machine**: All the samples were then subjected to testing using Universal Testing Machine (Hounsfield). The rod of universal testing machine was held perpendicular to the long axis of the tooth at the incisal third of the crown near the bonding line on the labial surface. The load was applied at a crosshead speed of 1 mm/min. The load was increased progressively and the value at which the reattached fragment debonded was recorded in kilograms and converted into Newton (N) using the relationship, 1 kg = 9.81 N. This load represented the fracture resistance of the reattached tooth. The fracture resistance of all the samples of each group was recorded similarly.

3. RESULTS

Table: 1 Mean and Standard deviation values of the fracture resistance for all the four groups

Groups		**N**	**Mean**	**Std. Deviation**	**Std. Error**
A	Dry storage	12	62.25	14.86	4.29
B	Milk	12	66.83	16.07	4.64
C	Saline	12	70.58	8.26	2.39
D	Egg white	12	53.33	26.33	7.60
	Total	48	63.25	18.24	2.63

Post hoc Tukey's test was performed for group wise comparison that showed no statistically significant difference in fracture resistance values between Group A and Group D (p=0.61, p> 0.005); Group B and Group D (p=0.25, p> 0.005); Group C and Group A (p=0.66, p>0.005); Group D and Group A (p=0.61, p> 0.005).

Table 2: Level of significance on intergroup comparison using post hoc Tukey's test

Group		Mean Difference (I-J)	Std. Error	Sig.
Dry storage (A)	**Milk (B)**	-4.58	7.19	0.92*
	Saline (C)	-8.33	7.19	0.66*
	Egg white (D)	8.92	7.19	0.61*
Milk (B)	**Dry storage (A)**	4.58	7.19	0.92*
	Saline (C)	-3.75	7.19	0.95*
	Egg white (D)	13.50	7.19	0.25*
Saline (C)	**Dry storage (A)**	8.33	7.19	0.66*
	Milk (B)	3.75	7.19	0.95*
	Egg white (D)	17.25	7.19	0.09*
Egg white (D)	**Dry storage (A)**	-8.92	7.19	0.61*
	Milk (B)	-13.50	7.19	0.25*
	Saline (C)	-17.25	7.19	0.09*

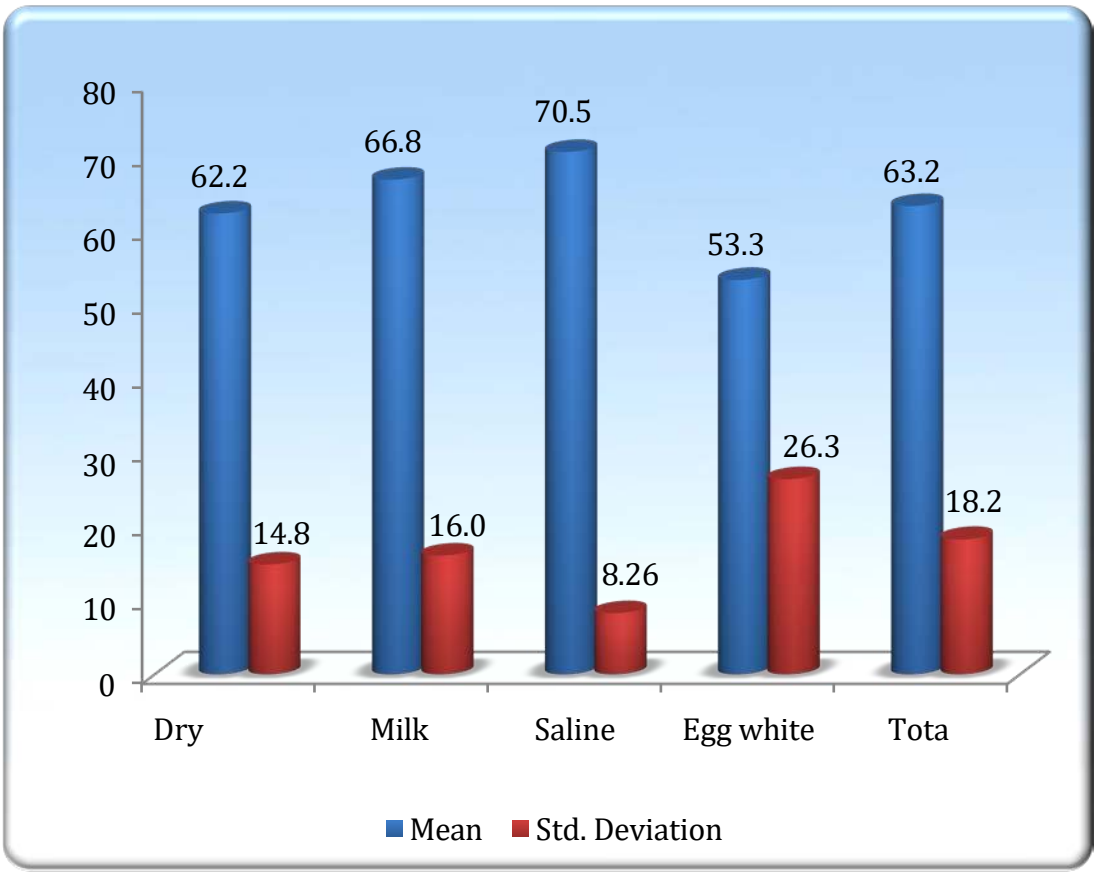
*Non-significant (p>0.05)

ANOVA indicated no significant difference between Group A, Group B, Group C, Group D

Table: 3 Comparison among values of the fracture resistance for all the four groups

	Sum of Squares	Df	Mean Square	F#	Sig.
Between Groups	1991.50	3.00	663.83	2.14	0.11*
Within Groups	13647.50	44.00	310.17		
Total	15639.00	47.00			

*Non-significant (p>0.05), # ANOVA test



Graph: 1 Mean and standard deviation values of the fracture resistance for all the Four groups

4. DISCUSSION

Dental trauma is a public health issue due to its high prevalence which varies between 7.4% and 58%. It can occur in the first years of life and increases during early development, mainly affecting children of school age (8–11 years).[8] One out of every three children have traumatized primary teeth, while 25% of children and almost 33% of adults experience trauma in the permanent dentition. Dental trauma generally affects a single tooth. However, traumatic events arising from sports, violence, and traffic accidents may result in multiple injuries. The teeth commonly involved include the anterior, especially the upper central and lateral incisors, followed by the lower incisors of both dentitions.[9]

Most common dental injuries in children and adolescents are coronal fractures of anterior teeth. The different techniques for the reconstruction of injured teeth are prosthodontic replacement by resin crowns, steel crowns, ceramic crowns, and resin composite restorations.[10]

The reattachment procedure usually involves storage and preparation of the fragment prior to its reattachment, and these procedures are important determinants of the overall clinical outcome. Accordingly, it recommended that the fragment be kept moist in either tap water or physiologic saline until its reattachment to prevent the occurrence of these problems.[11]

Some investigators claim that a good outcome can be achieved without additional preparation, such as making an internal enamel groove, an internal dentin groove, or a V-shaped groove in the external enamel of the tooth remnant and/or fragment prior to the reattachment procedure.

Others[12] recommend that the tooth remnant or fragment should undergo additional preparation before reattaching the fragment. In fact, results from in vitro studies on fragment reattachment have shown that additional preparation to the tooth remnant and/or fragment improves the bonding between the tooth remnant and fragment. The reattachment technique has many variations related to the selected additional tooth preparation and type of adhesive system (one, two or three steps; self-etching or pre-etching) and intermediate material (composite resin, flowable resin, resin cement, or glass ionomer).[13]

In this study, the teeth were cut in a standardized manner using a low-speed diamond disk, as the aim was to evaluate the storage media. The fitting between the fragment and the tooth was not always perfect. However, fracturing a tooth in vitro has its own disadvantages as the fractured fragments produced could be of uneven dimensions. As a result, the amount of

material required for reattachment will vary and give inconclusive results. Hence, with this limitation to simulate the natural fracture forces, this procedure of sectioning using a diamond disk was followed as it allows the standardization of the fragment size.[14]

In present study fracture resistance of the samples stored in saline (GroupC) was higher compared with those stored in milk (Group B).This can be due to the amount of water content in milk which is less than saline.The hydration of the collagen fibers could have been better achieved in saline leading to better fracture resistance .

Hence the storage media acts as one of the key determinants since hydration aids in maintaining the vitality, esthetic appearance and improving the bond strength.

Group D (egg white) demonstrated the least fracture resistance (53.33 N) with respect to Group B (milk) 66.83N and Group C (saline) 70.58 N. It could be attributed to the lower osmolality and greater viscosity of egg white as compared to that of saline which might have prevented uniform wetting of dentin as a result of which the collagen fibers could have remained in a collapsed state.[15] This particular aspect of our study is in contrast to a previous intervention by Shirani et al.[16]

Among easily available storage media, Normal saline offers highest fracture resistance.Milk offers fracture resistance higher than dry storage media but less than Normal saline. .Hence this study has potential to be the eye opener to the fact that the mode of storage of a fragment before its reattachment significantly affects the prognosis .Thus there is a need to catalyze public awareness about the manner of preservation of such fragments such as their avulsed counterparts.

5. CONCLUSION

This study shows that the use of storage media for the hydration of the fractured tooth fragment does affect its fracture resistance.

Within the limitations of this study:

it is concluded that Normal saline offers highest fracture resistance for 2 h. followed by Milk, with least being in Egg white.

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